EXHIBIT C

```
/*  ******************************************************************
    File: sslrec.c

    SSL Plus: Security Integration Suite(tm)
    Version 1.1.1 -- August 11, 1997

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    ******************************************************************

    File: sslrec.c     Encryption, decryption and MACing of data

    All the transformations which occur between plaintext and the
    secured, authenticated data that goes out over the wire. Also,
    detects incoming SSL 2 hello messages and hands them off to the SSL 2
    record layer (and hands all SSL 2 reading & writing off to the SSL 2
    layer).

    ***************************************************************** */

/* #define HYPER_DEBUG 1 */

#ifdef HYPER_DEBUG
#include <stdio.h>
#endif

#ifndef _SSL_H_
#include "ssl.h"
#endif

#ifndef _SSLREC_H_
#include "sslrec.h"
#endif

#ifndef _SSLALLOC_H_
#include "sslalloc.h"
#endif

#ifndef _CRYPTYPE_H_
#include "cryptype.h"
#endif

#ifndef _SSLCTX_H_
#include "sslctx.h"
#endif

#ifndef _SSLALERT_H_
#include "sslalert.h"
#endif

#ifndef _SSL2_H_
```

```
#include "ssl2.h"
#endif

#include <string.h>

static SSLErr DecryptSSLRecord(uint8 type, SSLBuffer *payload, SSLContext *ctx);
static SSLErr VerifyMAC(uint8 type, SSLBuffer data, uint8 *compareMAC, uint64 seqNo, SSLContext
    *ctx);
static SSLErr ComputeMAC(uint8 type, SSLBuffer data, SSLBuffer mac, uint64 seqNo, SSLBuffer
    secret, CipherContext *cipherCtx, SSLContext *ctx);
static uint8* SSLEncodeUInt64(uint8 *p, uint64 value);

/* ReadSSLRecord
 *  Attempt to read & decrypt an SSL record.
 */
SSLErr
SSLReadRecord(SSLRecord *rec, SSLContext *ctx)
{   SSLErr      err;
    uint32      len, contentLen;
    uint8           *progress;
    SSLBuffer       readData, cipherFragment;

#ifdef HYPER_DEBUG
   fprintf(stderr, "Got into SSLReadRecord, whee!\n");
#endif

   /* if we get UDP data when we aren't expecting it, that's really bad,
      so report an appropriate error. */
   if((rec->contentType == SSL_application_data_ssloppy) &&
      (! ctx->ssloppy))
          return SSLProtocolErr;



   if (!ctx->partialReadBuffer.data || ctx->partialReadBuffer.length < 5)
    {   if (ctx->partialReadBuffer.data)
            if ((err = SSLFreeBuffer(&ctx->partialReadBuffer, &ctx->sysCtx)) != 0)
            {   SSLFatalSessionAlert(alert_close_notify, ctx);
                return ERR(err);
            }
        if ((err = SSLAllocBuffer(&ctx->partialReadBuffer, DEFAULT_BUFFER_SIZE, &ctx->sysCtx))
   != 0)
        {   SSLFatalSessionAlert(alert_close_notify, ctx);
            return ERR(err);
        }
    }

    if (ctx->protocolVersion == SSL_Version_Undetermined ||
        ctx->protocolVersion == SSL_Version_3_0_With_2_0_Hello)
        if (ctx->amountRead < 1)
        {   readData.length = 1 - ctx->amountRead;
            readData.data = ctx->partialReadBuffer.data + ctx->amountRead;
            len = readData.length;
            if (ERR(err = ctx->ioCtx.read(readData, &len, ctx->ioCtx.ioRef)) != 0)
            {   if (err == SSLWouldBlockErr)
                    ctx->amountRead += len;
                else
                    SSLFatalSessionAlert(alert_close_notify, ctx);
                return err;
            }
            ctx->amountRead += len;
        }

/* In undetermined cases, if the first byte isn't in the range of SSL 3.0
 *  record types, this is an SSL 2.0 record
 */
    switch (ctx->protocolVersion)
    {   case SSL_Version_Undetermined:
        case SSL_Version_3_0_With_2_0_Hello:
            if (ctx->partialReadBuffer.data[0] < SSL_smallest_3_0_type ||
                ctx->partialReadBuffer.data[0] > SSL_largest_3_0_type)
                return SSL2ReadRecord(rec, ctx);
            else
                break;
        case SSL_Version_2_0:
            return SSL2ReadRecord(rec, ctx);
        default:
            break;
    }


#ifdef HYPER_DEBUG
    fprintf(stderr, "About to get into the read callback stuff\n");
#endif
    if (ctx->amountRead < 5)
    {   readData.length = 5 - ctx->amountRead;
        readData.data = ctx->partialReadBuffer.data + ctx->amountRead;
        len = readData.length;
        if (ERR(err = ctx->ioCtx.read(readData, &len, ctx->ioCtx.ioRef)) != 0)
        {   if (err == SSLWouldBlockErr)
                ctx->amountRead += len;
                        else if (err == SSLIOClosedOverrideGoodbyeKiss && ctx->amountRead ==
    0)
                        {   SSLClose(ctx);
                        return SSLConnectionClosedGraceful;
                        }
                        else
                                        SSLFatalSessionAlert(alert_close_notify, ctx);
                        return err;
                        }
        ctx->amountRead += len;
    }

    ASSERT(ctx->amountRead >= 5);

    progress = ctx->partialReadBuffer.data;
    rec->contentType = *progress++;
    if (rec->contentType < SSL_smallest_3_0_type ||
        rec->contentType > SSL_largest_3_0_type)
        return ERR(SSLProtocolErr);

    rec->protocolVersion = (SSLProtocolVersion)SSLDecodeInt(progress, 2);
    progress += 2;
    contentLen = SSLDecodeInt(progress, 2);
    progress += 2;
    if (contentLen > (16384 + 2048))     /* Maximum legal length of an SSLCipherText payload */
    {   SSLFatalSessionAlert(alert_unexpected_message, ctx);
        return ERR(SSLProtocolErr);
    }

    if (ctx->partialReadBuffer.length < 5 + contentLen)
    {   if ((err = SSLReallocBuffer(&ctx->partialReadBuffer, 5 + contentLen, &ctx->sysCtx)) !=
    0)
        {   SSLFatalSessionAlert(alert_close_notify, ctx);
            return ERR(err);
        }
    }

    if (ctx->amountRead < 5 + contentLen)
    {   readData.length = 5 + contentLen - ctx->amountRead;
        readData.data = ctx->partialReadBuffer.data + ctx->amountRead;
        len = readData.length;
        if (ERR(err = ctx->ioCtx.read(readData, &len, ctx->ioCtx.ioRef)) != 0)
        {   if (err == SSLWouldBlockErr)
                ctx->amountRead += len;
            else
                SSLFatalSessionAlert(alert_close_notify, ctx);
            return err;
        }
        ctx->amountRead += len;
    }

    ASSERT(ctx->amountRead >= 5 + contentLen);

    cipherFragment.data = ctx->partialReadBuffer.data + 5;
    cipherFragment.length = contentLen;

/* Decrypt the payload & check the MAC, modifying the length of the buffer to indicate the
 *  amount of plaintext data after adjusting for the block size and removing the MAC
 *  (this function generates its own alerts)
 */
    if ((err = DecryptSSLRecord(rec->contentType, &cipherFragment, ctx)) != 0)
        return err;

/* We appear to have sucessfully received a record; increment the sequence number */
    if(rec->contentType != SSL_application_data_ssloppy)
          IncrementUInt64(&ctx->readCipher.sequenceNum);


#ifdef SSL_COMPRESSION
          if((ctx->compressNow) && (ctx->selectedCompression != NULL) &&
                   (ctx->selectedCompression->identifier != 0)) {

/* Allocate a buffer to return the plaintext in and return it */
                    if ((err = SSLAllocBuffer(&rec->contents, DEFAULT_BUFFER_SIZE,
                            &ctx->sysCtx)) != SSLNoErr) {
                            SSLFatalSessionAlert(alert_close_notify, ctx);
                            return ERR(err);
                    }
                    if((err = ctx->selectedCompression->process(cipherFragment,
          &(rec->contents),
          ctx->readCompressRef,
          ctx)) != SSLNoErr) {
                            SSLFreeBuffer(&rec->contents, &ctx->sysCtx);
                            SSLFatalSessionAlert(alert_decompression_failure, ctx);
                            return ERR(err);
                    }
#ifdef HYPER_DEBUG
                    fprintf(stderr, "Deompression created output of %d from size %d\n",
                                               rec->contents.length,
   cipherFragment.length);
#endif
          } else {
                    if ((err = SSLAllocBuffer(&rec->contents, cipherFragment.length,
                            &ctx->sysCtx)) != 0)
                    {
                            SSLFatalSessionAlert(alert_close_notify, ctx);
                            return ERR(err);
                    }
                    memcpy(rec->contents.data, cipherFragment.data, (size_t)
   cipherFragment.length);
          }
#else
          memcpy(rec->contents.data, cipherFragment.data, (size_t) cipherFragment.length);
#endif

    ctx->amountRead = 0;        /* We've used all the data in the cache */

    return SSLNoErr;
}

/* SSLWriteRecord does not send alerts on failure, out of the assumption/fear
 *  that this might result in a loop (since sending an alert causes SSLWriteRecord
 *  to be called).
 */
```

```
SSLErr
SSLWriteRecord(SSLRecord rec, SSLContext *ctx)
{   SSLErr      err;
    int         padding = 0, i, freerec = 0;
    WaitingRecord   *out, *queue;
    SSLBuffer       buf, payload, secret, mac, nonce;
    uint8           *progress;
    uint16      payloadSize,blockSize,nonceSize = 0;

    if (rec.protocolVersion == SSL_Version_2_0)
        return SSL2WriteRecord(rec, ctx);

    ASSERT(rec.protocolVersion == SSL_Version_3_0);
    ASSERT(rec.contents.length <= 16384);

#ifdef SSL_COMPRESSION
        if((ctx->compressNow) && (ctx->selectedCompression != NULL) &&
                (ctx->selectedCompression->identifier != 0)) {
                        SSLBuffer compdata;

                        /* make a guess about how long the buffer will need to be */
                        if((err = SSLAllocBuffer(&compdata, rec.contents.length + 4,

                         &ctx->sysCtx)) != SSLNoErr)
                                    return ERR(err);
                        if((err = ctx->selectedCompression->process(rec.contents, &compdata,


        ctx->writeCompressRef,


        ctx)) != SSLNoErr) {
                                    SSLFreeBuffer(&compdata, &ctx->sysCtx);
                                    return ERR(err);
                        }

                        rec.contents = compdata;
                        freerec = 1;
        }
#endif

    out = 0;
    /* Allocate a WaitingRecord to store our ready-to-send record in */
    if ((err = SSLAllocBuffer(&buf, sizeof(WaitingRecord), &ctx->sysCtx)) != 0)
        return ERR(err);
    out = (WaitingRecord*)buf.data;
    out->next = 0;
    out->sent = 0;

/* Allocate enough room for the transmitted record, which will be:
     *  5 bytes of header +
     *  encrypted contents +
     *  macLength +
     *  padding [block ciphers only] +
     *  padding length field (1 byte) [block ciphers only]
     */
    payloadSize = (uint16) (rec.contents.length + ctx->writeCipher.hash->digestSize);
    blockSize = ctx->writeCipher.symCipher->blockSize;
    if (blockSize > 0)
    {   padding = blockSize - (payloadSize % blockSize) - 1;
        payloadSize = (uint16)(payloadSize + padding + 1);
    }

  if(ctx->ssloppy)
  {
          /* in this case we need more room, for the nonce */
          nonceSize = (uint16) MAX(sizeof(uint64), ctx->writeCipher.symCipher->ivSize);
/*        payloadSize += nonceSize; decided this was wrong logic */
  }

   out->data.data = 0;
```

```
    if ((err = SSLAllocBuffer(&out->data, 5 + payloadSize + nonceSize,
                                                    &ctx->sysCtx)) != 0)
        goto fail;

    progress = out->data.data;
    *(progress++) = rec.contentType;
    progress = SSLEncodeInt(progress, rec.protocolVersion, 2);
    progress = SSLEncodeInt(progress, payloadSize, 2);

    /* Copy the contents into the output buffer */
    memcpy(progress, rec.contents.data, (size_t) rec.contents.length);
    payload.data = progress;
    payload.length = rec.contents.length;

    progress += rec.contents.length;
    /* MAC immediately follows data */
    mac.data = progress;
    mac.length = ctx->writeCipher.hash->digestSize;
    progress += mac.length;

  if(ctx->ssloppy)
  {
        uint64 noncevalue;

        if((err = SSLAllocBuffer(&nonce, nonceSize, &ctx->sysCtx)) != SSLNoErr)
                goto fail;
        if((err = ctx->sysCtx.random(nonce, ctx->sysCtx.randomRef)) != SSLNoErr)
                goto fail;

        memcpy(&noncevalue, nonce.data, sizeof(noncevalue));

        /* MAC the data, sloppy-style */
        if (mac.length > 0) /* Optimize away null case */
        {
                secret.data = ctx->writeCipher.macSecret;
                secret.length = ctx->writeCipher.hash->digestSize;
                if ((err = ComputeMAC(rec.contentType, payload, mac, noncevalue,
                                            secret, &ctx->writeCipher, ctx)) != 0)
                        goto fail;
        }

        memcpy(progress, nonce.data, nonce.length);
        progress += nonce.length;

  }
  else
  {
        /* MAC the data, normal mode */
        if (mac.length > 0) /* Optimize away null case */
        {
                secret.data = ctx->writeCipher.macSecret;
                secret.length = ctx->writeCipher.hash->digestSize;
                if ((err = ComputeMAC(rec.contentType, payload, mac,
                                            ctx->writeCipher.sequenceNum, secret,
                                            &ctx->writeCipher, ctx)) != 0)
                        goto fail;
        }
  }

   /* Update payload to reflect encrypted data: contents, mac & padding */
   payload.length = payloadSize;

   /* Fill in the padding bytes & padding length field with the padding value; the
    *  protocol only requires the last byte,
    *  but filling them all in avoids leaking data
    */
   if (ctx->writeCipher.symCipher->blockSize > 0)
       for (i = 1; i <= padding + 1; ++i)
           payload.data[payload.length - i] = (uint8)padding;

   /* Encrypt the data */
```

```
    DUMP_BUFFER_NAME("cleartext data", payload);
   if ((err = ctx->writeCipher.symCipher->encrypt(payload, payload,
                                                                                              ctx-
   >ssloppy ? &nonce:NULL,
                                                                                              ctx-
   >writeCipher.symCipherState,
                                                                                              ctx))
   != 0)
            goto fail;

    DUMP_BUFFER_NAME("encrypted data", payload);

    /* Enqueue the record to be written from the idle loop */
    if (ctx->recordWriteQueue == 0)
        ctx->recordWriteQueue = out;
    else
    {   queue = ctx->recordWriteQueue;
        while (queue->next != 0)
            queue = queue->next;
        queue->next = out;
    }

   if(ctx->ssloppy)
          SSLFreeBuffer(&nonce, &ctx->sysCtx);
   else
          /* Increment the sequence number */
          IncrementUInt64(&ctx->writeCipher.sequenceNum);

   if(freerec)
          SSLFreeBuffer(&(rec.contents), &ctx->sysCtx);

    return SSLNoErr;

fail:   /* Only for if we fail between when the WaitingRecord is allocated and when it is
   queued */
    SSLFreeBuffer(&out->data, &ctx->sysCtx);
    buf.data = (uint8*)out;
    buf.length = sizeof(WaitingRecord);
    SSLFreeBuffer(&buf, &ctx->sysCtx);
          if(freerec)
                          SSLFreeBuffer(&(rec.contents), &ctx->sysCtx);
    return ERR(err);
}

static SSLErr
DecryptSSLRecord(uint8 type, SSLBuffer *payload, SSLContext *ctx)
{   SSLErr  err;
    SSLBuffer   content, nonce;

   if(type == SSL_application_data_ssloppy)
   {
          nonce.length = MAX(sizeof(uint64), ctx->readCipher.symCipher->ivSize);
          nonce.data = payload->data + (payload->length - nonce.length);
          payload->length -= nonce.length;
   }

    if ((ctx->readCipher.symCipher->blockSize > 0) &&
        ((payload->length % ctx->readCipher.symCipher->blockSize) != 0))
    {   SSLFatalSessionAlert(alert_unexpected_message, ctx);
        return ERR(SSLProtocolErr);
    }

    /* Decrypt in place */
    DUMP_BUFFER_NAME("encrypted data", (*payload));

   if(type == SSL_application_data_ssloppy)
   {
          if ((err = ctx->readCipher.symCipher->decrypt(*payload, *payload, &nonce, ctx-
   >readCipher.symCipherState, ctx)) != 0)
          {
```

```
                        SSLFatalSessionAlert(alert_close_notify, ctx);
                        return ERR(err);
                }
        }
        else
        {
                if ((err = ctx->readCipher.symCipher->decrypt(*payload, *payload, NULL, ctx->readCipher.symCipherState, ctx)) != 0)
                {   SSLFatalSessionAlert(alert_close_notify, ctx);
              return ERR(err);
                }
        }
          DUMP_BUFFER_NAME("decrypted data", (*payload));

  /* Locate content within decrypted payload */
      content.data = payload->data;
      content.length = payload->length - ctx->readCipher.hash->digestSize;
      if (ctx->readCipher.symCipher->blockSize > 0)
      {   /* padding can't be equal to or more than a block */
          if (payload->data[payload->length - 1] >= ctx->readCipher.symCipher->blockSize)
          {   SSLFatalSessionAlert(alert_unexpected_message, ctx);
              return ERR(SSLProtocolErr);
          }
          content.length -= 1 + payload->data[payload->length - 1];   /* Remove block size padding */
      }

  /* Verify MAC on payload */
      if (ctx->readCipher.hash->digestSize > 0)       /* Optimize away MAC for null case */
              if(type == SSL_application_data_ssloppy)
              {
                      uint64 nonceNumber;

                      memcpy(&nonceNumber, nonce.data, sizeof(nonceNumber));
                      if ((err = VerifyMAC(type, content, payload->data + content.length,
                                                                       nonceNumber, ctx)) != 0)
                      {
                              SSLFatalSessionAlert(alert_bad_record_mac, ctx);
                              return ERR(err);
                      }
              }
              else
              {
                      if ((err = VerifyMAC(type, content, payload->data + content.length,
                                                                       ctx->readCipher.sequenceNum, ctx)) != 0)
                      {
                              SSLFatalSessionAlert(alert_bad_record_mac, ctx);
                              return ERR(err);
                      }
              }


      *payload = content; /* Modify payload buffer to indicate content length */

      return SSLNoErr;
}

static uint8*
SSLEncodeUInt64(uint8 *p, uint64 value)
{   p = SSLEncodeInt(p, value.high, 4);
    return SSLEncodeInt(p, value.low, 4);
}

static SSLErr
VerifyMAC(uint8 type, SSLBuffer data, uint8 *compareMAC, uint64 seqNo, SSLContext *ctx)
{   SSLErr      err;
    uint8           macData[MAX_DIGEST_SIZE];
    SSLBuffer       secret, mac;

    secret.data = ctx->readCipher.macSecret;
    secret.length = ctx->readCipher.hash->digestSize;
    mac.data = macData;
    mac.length = ctx->readCipher.hash->digestSize;

    if ((err = ComputeMAC(type, data, mac, seqNo, secret,
                    &ctx->readCipher, ctx)) != 0)
        return ERR(err);

    if ((memcmp(mac.data, compareMAC, (size_t) mac.length)) != 0)
        return ERR(SSLProtocolErr);

    return SSLNoErr;
}

static SSLErr
ComputeMAC(uint8 type, SSLBuffer data, SSLBuffer mac, uint64 seqNo, SSLBuffer secret,
            CipherContext *cipherCtx, SSLContext *ctx)
{   SSLErr      err;
    uint8           innerDigestData[MAX_DIGEST_SIZE];
    uint8           scratchData[11], *progress;
    SSLBuffer       digest, scratch;

#ifdef HYPER_DEBUG
  int i;
  fprintf(stderr, "Buffer: ");
  for(i = 0; i < data.length; i++)
          fprintf(stderr, "%02x ", data.data[i]);
  fprintf(stderr, "\n");

  fprintf(stderr, "sequenceno: ");
  for(i = 0; i < sizeof(uint64); i++)
          fprintf(stderr, "%02x ", (unsigned char) *((unsigned char *) &seqNo) + i);
  fprintf(stderr, "\n");

  fprintf(stderr, "Secret: ");
  for(i = 0; i < secret.length; i++)
          fprintf(stderr, "%02x ", secret.data[i]);
  fprintf(stderr, "\n");
#endif

    ASSERT(cipherCtx->hash->macPadSize <= MAX_MAC_PADDING);
    ASSERT(cipherCtx->hash->digestSize <= MAX_DIGEST_SIZE);
    ASSERT(SSLMACPad1[0] == 0x36 && SSLMACPad2[0] == 0x5C);

    if(cipherCtx->digestCtx.data == NULL) {
      if ((err = SSLAllocBuffer(&cipherCtx->digestCtx,
                        cipherCtx->hash->contextSize, &ctx->sysCtx))
     != 0)
        goto exit;
      cipherCtx->hash->create(cipherCtx->digestCtx);
    }

/* MAC = hash( MAC_write_secret + pad_2 + hash( MAC_write_secret + pad_1 + seq_num + type +
   length + content ) ) */
    if ((err = cipherCtx->hash->init(cipherCtx->digestCtx)) != 0)
        goto exit;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, secret)) != 0)    /* MAC secret */
        goto exit;
    scratch.data = SSLMACPad1;
    scratch.length = cipherCtx->hash->macPadSize;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, scratch)) != 0)   /* pad1 */
        goto exit;
    progress = scratchData;
    progress = SSLEncodeUInt64(progress, seqNo);
    *progress++ = type;
    progress = SSLEncodeInt(progress, data.length, 2);
    scratch.data = scratchData;
    scratch.length = 11;
    ASSERT(progress == scratchData+11);
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, scratch)) != 0)   /* sequenceNo,
   type & length */
```

```
        goto exit;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, data)) != 0)  /* content */
        goto exit;
    digest.data = innerDigestData;
    digest.length = cipherCtx->hash->digestSize;
    if ((err = cipherCtx->hash->final(cipherCtx->digestCtx, digest)) != 0) /* figure inner
  digest */
        goto exit;

    if ((err = cipherCtx->hash->init(cipherCtx->digestCtx)) != 0)
        goto exit;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, secret)) != 0)    /* MAC secret */
        goto exit;
    scratch.data = SSLMACPad2;
    scratch.length = cipherCtx->hash->macPadSize;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, scratch)) != 0)   /* pad2 */
        goto exit;
    if ((err = cipherCtx->hash->update(cipherCtx->digestCtx, digest)) != 0)    /* inner digest
  */
        goto exit;
    if ((err = cipherCtx->hash->final(cipherCtx->digestCtx, mac)) != 0)    /* figure the mac */
        goto exit;

    err = SSLNoErr; /* redundant, I know */

exit:
    return ERR(err);
}
```